SEASONAL FLUCTUATIONS OF FUNGI IN EGYPTIAN SOIL RECEIVING CITY SEWAGE EFFLUENTS

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SUMMARY. — Using the dilution plate methods, 30 genera and 86 species in addition to 4 varieties were recovered from 24 soil samples irrigated by sewage effluents during January 1985 - December 1986 on glucose (26 genera and 74 species + 4 varieties) and cellulose (23 genera and 48 species + 2 varieties) Czapek's agar at 28°C. The composition of the mycoflora on the two media were basically similar, but the frequencies of occurrence of some genera and species were promoted or decreased more on cellulose than on glucose agar plates. The total counts of glycophilic and cellulose-decomposing fungi were irregularly fluctuated and the peaks were recorded in March 1985, and May/October 1986 on the two media, respectively. On glucose agar the most common species were *Aspergillus fumagatus, A. niger, A. sydowi, Penicillium chrysogenum, Mucor hiemalis* and *Fusarium solani*. On cellulose agar the most prevalent species were *A. flavus, A. fumigatus, P. chrysogenum, Mucor racemosus, Acremonium strictum, Stachybotrys chartarum, F. solani* and *Chaetomium globosum*.

RÉSUMÉ. — A partir de 24 échantillons de sol irrigué par des eaux usées, recueillis entre Janvier 1985 et Décembre 1986, 30 genres et 86 espèces plus 4 variétés de champignons ont été récupérés à 28°C sur milieu Czapek-agar contenant du glucose (26 genres et 74 espèces + 4 variétés) et de la cellulose (23 genres et 48 espèces + 2 variétés). La composition de la mycoflore sur ces deux milieux est similaire, mais les fréquences d'apparition de quelques genres et espèces varient. Les nombres totaux de champignons glycophyles et de champignons cellulolytiques fluctuent irrégulièrement, les maxima ayant été enregistré respectivement en Mars 1985 et Mai/Octobre 1986. *Aspergillus fumigatus, A. niger, A. sydowi. Penicillium chrysogenum, Mucor hiemalis* et *Fusarium solani* sont les plus communs sur glucose. Sur cellulose, les espèces dominantes sont *A. flavus, A. fumigatus, P. chrysogenum, Mucor racemosus, Acremonium strictum, Stachybotrys chartarum, F. solani* et *Chaetomium globosum*.

KEY WORDS : Soil fungi, glycophilic fungi, cellulose-decomposing fungi.

INTRODUCTION

As a new science, irrigation with sewage effluents is still in the experimental stages and many problems need to be solved in the field of hygiene, biology and microbiology. In the world, numerous investigations were carried out on the

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mycoflora of soil through the use of sewage as an irrigation supplement (COOKE, 1963, 1971; COOKE & PIPES, 1970; DIENER & al., 1976; EILAND, 1981; LARRY & WANGER, 1982). In Egypt, there is no information about the mycoflora of soil irrigated by city sewage effluents and all studies have been focused on cultivated soil irrigated by freshwater from River Nile (MOUBASHER & MOUSTAFA, 1970; MOUBASHER & EL-DOHLOB, 1970; MOUBASHER & MAZEN, 1971; MOUBASHER & al., 1971; MOUBASHER & ABDEL-HAFEZ, 1978a, b). The present investigation is aimed to study the density, frequency of occurrence and seasonal incidence of fungal population in soil regularly irrigated by city sewage effluents.

MATERIALS AND METHODS

Three kilometers out of Assiut city, a plot of sandy soil (about 30 acres in area) were cultivated by different crops (maize, sorghum and wheat) and irrigated monthly by domestic sewage effluent received from the city refuses and ccording to the system designed for each crop. Monthly soil samples were collected during January 1985 - December 1986. The soil samples were analysed chemically for the estimation of organic matter contents and total soluble salts. A Bekman pH-meter was used for the determination of soil pH.

Determination of soil fungi :

The dilution-plate method was used for the estimation of soil fungi as described by JOHNSON & al. (1959), but with some modifications as employed by MOUBASHER & ABDEL-HAFEZ (1978 a, b). Glucose- (10 g/l) and cellulose- (21.9 g/l) Czapek's agar were used as isolation media. To these media rose bengal (1/15000) was added as a bacteriostatic agent (SMITH & DAWSON, 1944). Ten plates were used for each sample, of which 5 plates were poured with glucose-agar and the other 5 plates with cellulose-Czapek's agar. Plates were incubated at 28°C for 7-10 days and the growing fungi were identified, counted and the numbers were calculated per mg dry soil.

RESULTS AND DISCUSSION

The organic matter contents and total soluble salts of soil tested with sewage were generally moderate and fluctuated between 3.3 and 4.2 % and between 1.2 and 2.4 %, respectively. pH values of the soil samples ranged between 6.9-8.4, and most of the samples were alkaline. MOUBASHER & ABDEL-HAFEZ (1978b) found that the organic matter contents and total soluble salts in Egyptian cultivated soils irrigated by water from River Nile during January-December 1972 and 1973, were low compared with soil receiving sewage and ranged between 1.5 and 2.4 %, and between 0.03 and 0.25%, respectively. pH values of these soils were alkaline with pH from 7.3 to 8.5.

I - Fungi recovered on glucose-Czapek's agar :

The total counts of glycophilic fungi in soils receiving sewage were irregularly fluctuated and widely ranged between 7 and 429 colonies/mg dry soil (compared with 11.5-26.6 colonies/mg dry soil in cultivated clay soils irrigated by water from River Nile). The highest counts were estimated in February (315 colonies) and March (429 colonies) 1985 and the poorest in January, June and September 1985 (22, 7 and 23 colonies, respectively) as shown in Figure 1 and Table 2. In U.S.A., COOKE & PIPES (1970) reported that the highest fungal counts in soil receiving sewage were recorded in spring and fewest in summer months. Also, addition of sewage to soil increase the total count of microorganisms (CLATHE & MAKANI, 1963; EILAND, 1981; LARRY & WANGER, 1982).

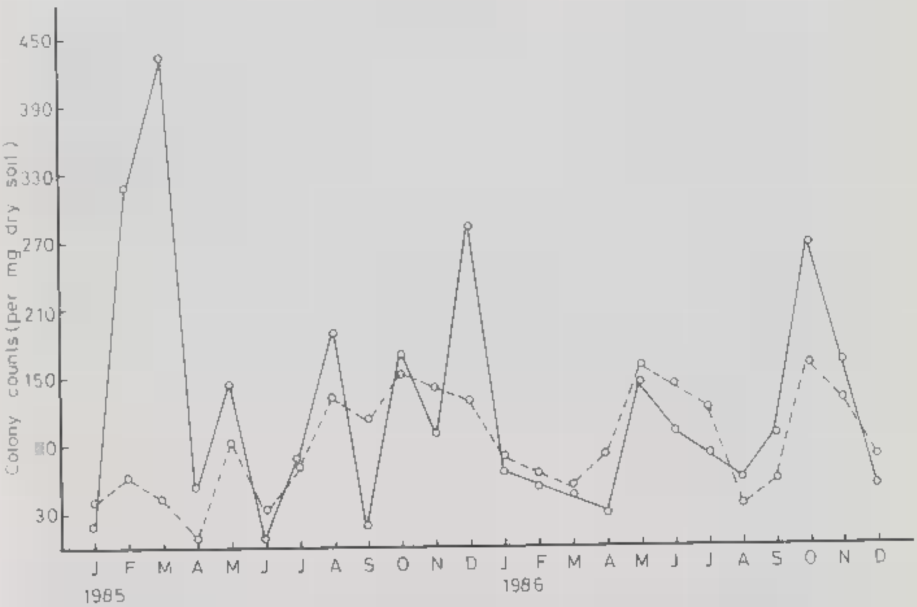


Figure 1. — Monthly total counts of glycophilic (——) and cellulose-decomposing fungi (- - -) recovered during January 1985 - December 1986.

Figure 1. — Dénombrements mensuels des champignons glycophiles (——) et cellulolytiques (- - -) isolés entre Janvier 1985 et Décembre 1986.

Twenty six genera and 74 species in addition to 4 varieties were collected from 24 monthly soil samples tested during January - December 1985-1986 (Table 1). COOKE (1971) collected 56 fungal species from UK soil samples in which digested sewage was added triweekly.

Four genera were isolated in high seasonal frequency of occurrence and these were *Aspergillus*, *Penicillium*, *Mucor* and *Fusarium*. *Aspergillus* was the most common genera, and emerged in 100 % of the samples comprising 36.6 % of

Table 1 – Total count (calculated per mg dry soil in every sample), percentage count (calculated to total fungi) and number of cases of isolation of each of fungal genera and species isolated from the 24 soil samples, recovered on glucose- and cellulose-Czapek's agar incubated at 28°C.

Tableau 1 – Genres et espèces de champignons isolés à partir de 24 échantillons de sol, sur milieux Czapek (glucose et cellulose) à 28°C.

Organisms	Glucose				Cellulose			
	TC	% TC	NCI	OR	TC	% TC	NCI	OR
Total count	*3023.4*				*2196.2*			
Aspergillus (total count)	*1108.2*	36.6	24	H	*990.8*	45.1	23	H
A. fumigatus Fres.	450.2	14.8	24	H	586.8	26.7	21	H
A. niger Van Tiegh.	183.8	6.1	17	H	95.6	4.3	9	M
A. sydowi (Bain. & Sart.) Thom & Church	98.8	3.2	15	H	8.2	0.37	4	L
A. terreus Thom	148.8	4.9	14	H	–	–	–	–
A. flavus (Link) Fries.	99.4	3.3	13	H	174.8	7.9	18	H
A. falvus var. *columnaris* Link	18.2	0.60	8	M	66.4	3.0	7	M
A. nidulans Eidam	16.0	0.52	7	M	80.8	3.2	11	M
A. ochraceus Wilhelm	29.0	0.96	5	L	6.2	0.28	4	L
A. sulphureus (Fres.) Thom & Church	8.2	0.27	4	L	–	–	–	–
A. clavatus Desmazières	3.4	0.11	3	L	–	–	–	–
A. tamarii Kita	7.0	0.22	3	L	–	–	–	–
A. candidus Link ex Fr.	6.0	0.19	2	R	–	–	–	–
A. flavipes (Bain. & Sart.) Thom & Church	2.4	0.08	2	R	–	–	–	–
A. fischeri Wehmer	2.6	0.09	2	R	–	–	–	–
A. nidulans var. *latus* Thom & Raper	5.2	0.17	2	R	26.4	1.2	7	M
A. niveus Blochwitz	5.4	0.18	2	R	–	–	–	–
A. terreus var. *africanus* Fennel & Raper	12.8	0.42	2	R	–	–	–	–
A. versicolor (Vuill.) Tirab.	6.0	0.19	2	R	–	–	–	–
A. clavato-nanica Bat., Maia Alecrim	1.0	0.03	1	R	–	–	–	–
A. quadrilineatus Thom & Raper	2.0	0.06	1	R	0.4	0.02	1	R
A. rugulosus Thom & Raper	2.0	0.06	1	R	3.2	0.14	3	L
A. wentii Whemer	–	–	–	–	2.0	0.09	1	R
Penicillium (total count)	*885.0*	29.3	20	H	*160.0*	7.3	18	H
P. chrysogenum Thom	560.8	18.5	18	H	76.4	3.5	15	H
P. nigricans Bainier	57.6	1.9	8	M	12.8	0.58	4	L
P. funiculosum Thom	35.2	1.16	7	M	34.8	1.58	10	M
P. brevicompactum Dierckx	102.4	3.38	6	M	7.2	0.32	3	L
P. oxalicum Currie & Thom	27.6	0.91	5	L	6.2	0.28	2	R
P. citrinum Thom	14.8	0.48	4	L	17.6	0.80	5	L
P. corylophilum Dierckx	36.2	1.19	3	L	–	–	–	–
P. cyclopium Westling	21.4	0.71	3	L	–	–	–	–
P. janthinellum Biourge	3.2	0.10	3	L	–	–	–	–

Organisms	Glucose				Cellulose			
	TC	% TC	NCI	OR	TC	% TC	NCI	OR
P. frequentans Westling	15.0	0.49	2	R	5.0	0.22	1	R
P. rugulosum Thom	3.8	0.12	2	R	–	–	–	–
P. purpurogenum Stoll	2.8	0.09	1	R	–	–	–	–
. steckii Zaleski	1.8	0.06	1	R	–	–	–	–
. rubrum Stoll	1.4	0.05	1	R	–	–	–	–
thomii Maire	1.0	0.03	1	R	–	–	–	–
lucor (total count)	*267.8*	8.85	18	H	*26.6*	1.2	16	H
l. hiemalis Wehmeyer	111.2	3.67	13	H	–	–	–	–
circinelloides Van Tieghem	80.0	2.64	8	M	–	–	–	–
l. racemosus Fresenius	76.6	2.53	5	L	126.6	5.7	16	H
usarium (total count)	*137.4*	4.54	16	H	*116.0*	5.3	12	H
. solani (Mart.) Sacc.	79.8	2.63	10	M	51.6	2.3	8	M
. oxysporum Schlech. ex Fr.	36.4	1.2	7	M	30.6	1.4	5	L
. moniliforme Sheldon	6.2	0.2	3	L	33.8	1.5	6	M
. poae (Peck) Wollenw.	2.0	0.06	2	R	–	–	–	–
equiseti (Corda) Sacc.	2.0	0.06	1	R	–	–	–	–
moniliforme var. *subglutinans* Wollenw. & Reink.	2.0	0.06	1	R	–	–	–	–
semitectum Berk. & Rav.	2.0	0.06	1	R	–	–	–	–
tricinctum (Corda) Sacc.	7.0	0.22	1	R	–	–	–	–
cremonium (total count)	*120.2*	3.97	9	M	*130.8*	5.9	13	H
rutilum W. Gams	90.4	2.99	8	M	–	–	–	–
strictum W. Gams	24.4	0.80	4	L	130.8	5.9	13	H
implicatum (Gilman & Abb.) Gams	5.4	0.18	1	R	–	–	–	–
pulariopsis (total count)	*43.4*	1.43	8	M	*71.0*	3.2	10	M
brevicaulis (Sacc.) Bainier	39.2	1.29	7	M	58.0	2.6	6	M
rumptii Salvanet-Dauval	4.2	0.14	2	R	13.0	0.59	4	L
ryotrichum (total count)	*116.2*	3.84	7	M	*183.4*	8.3	10	M
trogriseum Van Beyma	100.8	3.32	6	M	183.4	8.3	10	M
piluliferum Saccardo & Marchal	15.4	0.5	3	L	–	–	–	–
ichoderma (total count)	*131.6*	4.3	7	M	*70.6*	3.2	8	M
viride Pers. ex Fr.	94.0	3.1	6	M	56.6	2.6	7	M
album Preuss	37.6	1.2	4	L	14.0	0.63	3	L
ecilomyces (total count)	*20.0*	0.66	4	L	*12.8*	0.58	3	L
variotii Bainier	15.0	0.49	3	L	8.8	0.40	3	L
terricola (Miller et al.) Onions & Barron	5.0	0.16	1	R	–	–	–	–
roseolus G. Smith	–	–	–	–	4.0	0.18	1	R
lindrocarpon (total count)	*6.0*	1.9	3	L	*2.0*	0.09	1	R
radicicola Wollenweber	4.0	0.13	2	R	–	–	–	–
lichenicola (G. Mass.) Hawksw.	2.0	0.06	1	R	2.0	0.09	1	R
Drechslera halodes (Drech) Subram & Jain	7.0	0.22	3	L	–	–	–	–
Rhizopus (total count)	*9.0*	0.29	3	L	*0.6*	0.03	1	R

Organisms	Glucose				Cellulose			
	TC	% TC	NCI	OR	TC	% TC	NCI	OR
R. stolonifer Ehren. ex Fr. Vuill.	7.0	0.22	2	R	0.6	0.03	1	R
R. nigricans Ehrenberg	2.0	0.06	1	R	–	–	–	–
Stachybotrys (total count)	*6.6*	0.21	3	L	*112.0*	5.1	15	H
S. chartarum (Ehr. ex Link.) Hughes	6.6	0.21	3	L	94.0	4.3	13	H
S. microspora (Mat. & Sank.) Tong & Devis	–	–	–	–	18.0	0.81	4	L
Alternaria alternata (Fr.) Keissler	4.0	0.13	2	R	14.2	0.63	2	R
Chaetomium (total count)	*2.2*	0.07	2	R	*43.2*	1.96	6	M
C. globosum Kunz ex Fr.	2.0	0.06	2	R	27.2	1.2	4	L
C. olivaceum Cooke & Ellis	0.2	0.01	1	R	12.0	0.54	2	R
C. spirale Zopf	–	–	–	–	4.0	0.18	1	R
Gliocladium catenulatum Gilman & Abbott	10.0	0.33	2	R	4.0	0.18	1	R
Sepedonium chrysospermum (Bull.) Link	11.0	0.34	2	R	24.0	1.10	2	R
Absidia corymbifera Lichth.	2.0	0.06	1	R	–	–	–	–
Chrysosporium pannorum (Link) Hughes	5.0	0.16	1	R	–	–	–	–
Cladosporium herbarum (Pers.) Link ex Fr.	7.0	0.22	1	R	1.0	0.04	1	R
Circinella muscae (Sorok.) Berl. & De Toni	45.0	1.48	1	R	–	–	–	–
Curvularia (total count)	*0.6*	0.02	1	R	*8.0*	0.36	2	R
C. tuberculata Jaim	0.6	0.02	1	R	–	–	–	–
C. lunata (Walker) Boedijn	–	–	–	–	4.0	0.18	1	R
C. spicifera (Bainier) Boedijn	–	–	–	–	4.0	0.18	1	R
Humicola grisea Traaen	8.0	0.26	1	R	23.6	1.07	5	L
Geotrichum candidum Link	4.0	0.13	1	R	–	–	–	–
Torula herbarum (Pers.) Link ex Fries	1.8	0.07	1	R	–	–	–	–
Trimmatostroma salicis Corda	4.0	0.13	1	R	–	–	–	–
Verticillium (total count)	–	–	–	–	*49.4*	2.2	5	L
V. candelabrum Bonorden	–	–	–	–	27.6	1.2	4	L
V. lateritium (Ehr.) Rabenhorst	–	–	–	–	21.8	0.99	2	R
Myrothecium (total count)	–	–	–	–	*11.4*	0.52	4	L
M. verrucaria Ditmar ex Fr.	–	–	–	–	6.0	0.30	3	L
M. roridum Tode ex Fries	–	–	–	–	5.4	0.24	2	R
Pseudobotrytis bisbyi Timonin	–	–	–	–	29.0	1.3	3	L
Trichurus spiralis Hasselbring	–	–	–	–	2.0	0.09	1	R
Mycelia sterilia (white, yellow and dark colour)	60.0	1.98	13	H	9.8	0.44	5	L

TC : total count per mg dry soil in every sample. % TC : percentage count (calculated to total fungi). NCI : number of cases of isolation (out of 24 samples). OR : occurrence remark. H : high occurrence, more than 11 cases. M : moderate occurrence, between 6-11 cases. L : low occurrence, between 3-5 cases. R : rare occurrence, less than 3 cases.

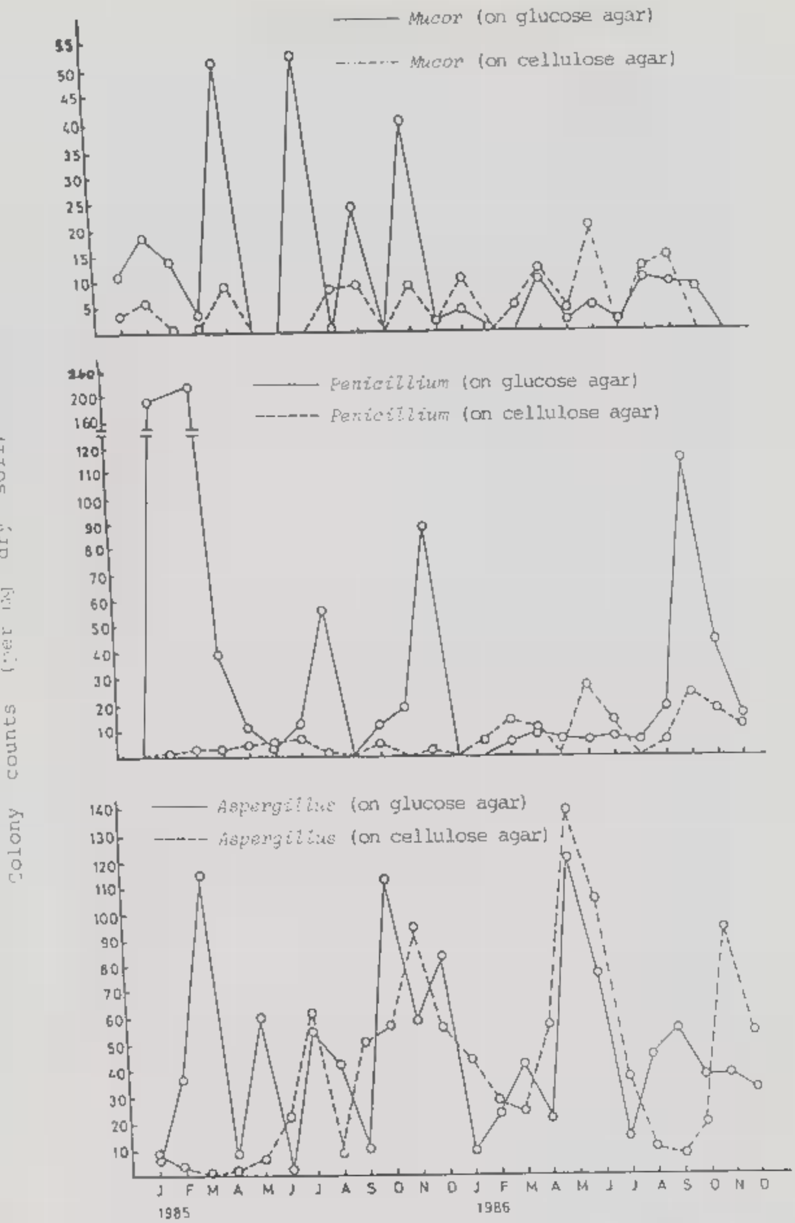


Figure 2 — Monthly counts (calculated per mg dry soil) of *Aspergillus*, *Penicillium* and *Mucor* recovered on glucose- and cellulose-Czapek's agar during January 1985 - December 1986.

Figure 2 — Dénombrements mensuels des *Aspergillus*, *Penicillium* et *Mucor* isolés sur milieux Czapek (glucose et cellulose) entre Janvier 1985 et Décembre 1986.

Table 2 – Monthly total count (per mg dry soil) of common glycophilic (G) and cellulose-decomposing (C) fungi recovered on glucose- and cellulose-Czapek's agar at 28°C during the periods January 1985 to December 1986.

Tableau 2 – Genres de champignons glycophiles et cellulolytiques les plus communs isolés sur milieux Czapek (glucose et cellulose) entre Janvier 1985 et Décembre 1986.

Months / Genera	1985 J	F	M	A	M	J	J	A	S	O	N	D
Gross total count (G)	22	315	429	57.4	147	7	77.4	188.2	23	167.4	108.6	288
Gross total count (C)	39.8	62.2	45.2	12.8	91.2	31.8	73.2	135	114	153	144	127
Aspergillus (G)	6.0	37	115	8.2	60.6	2.6	54.6	40.2	10	114	59	[illegible]
Aspergillus (C)	6.4	3.6	0.6	1.2	6.0	22.2	61.8	9.0	51	57	95	56
Penicillium (G)	–	198	210	39.6	10.8	3.2	12.6	55.8	–	12	19	89
Penicillium (C)	–	0.8	2.6	2.4	4.2	4.2	6.6	1.2	–	5	–	2
Mucor (G)	11	18	14	3.4	51.6	–	–	52.8	–	20	–	40
Mucor (C)	3.2	6.2	0.2	0.6	8.4	–	–	–	[illegible]	[illegible]	–	9
Fusarium (G)	3	15	36	0.6	10.8	–	–	18	2	4	–	18
Fusarium (C)	15.4	10.8	12.6	2.6	9.6	–	–	18	–	11	5	12
Stachybotrys (G)	–	–	–	–	–	0.6	–	–	–	–	–	–
Stachybotrys (C)	3.2	24.4	5.2	0.8	12	1.8	1.8	13.8	3	5	–	–
Acremonium (G)	–	34	–	0.8	–	0.4	–	–	–	5	7	20
Acremonium (C)	1.8	1.4	–	0.2	13.2	1.8	2.4	–	–	12	5	18

Months / Genera	1986 J	F	M	A	M	J	J	A	S	O	N	D
Gross total count (G)	47	42	[illegible]	32	147	104	79	64	112	268	109	55
Gross total count (C)	82	67	42	81	158	147	123	37	63	158	130	79
Aspergillus (G)	9	23	42	21	122	77	14	45	55	37	38	32
Aspergillus (C)	44	28	24	57	140	106	37	10	7	19	95	54
Penicillium (G)	–	–	5	9	7	6	7	6	19	115	45	16
Penicillium (C)	–	[illegible]	14	10	–	27	14	–	6	24	18	12
Mucor (G)	2	4	1	–	10	2	5	2	10	9	8	–
Mucor (C)	5	10	–	5	12	4	20	–	12	14	–	–
Fusarium (G)	15	2	–	2	1	4	–	–	–	4	2	–
Fusarium (C)	–	–	–	9	–	–	5	–	–	5	–	–
Stachybotrys (G)	4	–	–	–	–	–	–	2	–	–	–	–
Stachybotrys (C)	19	–	4	–	–	–	–	10	6	–	2	–
Acremonium (G)	–	–	–	–	–	–	34	–	–	5	14	–
Acremonium (C)	–	5	–	–	–	–	5	–	7	58	–	–

total fungi. Its total count was irregularly fluctuated and the maximum were recorded in March (115 colonies) and October (114 colonies) 1985 and May (112 colonies) 1986, as shown in Table 2 and Figure 2. It was representated by 19 species and 3 varieties of which *A. fumigatus, A. niger, A. sydowi, A. terreus* and *A. flavus* were the most glycophilic and hydrophilic species of the genus. Their counts were almost parallel to those of the genus and the best counts were estimated in October (93 colonies) 1985, March (69 colonies) 1985, December (25 colonies) 1985, June (43 colonies) 1986 and September (17 colonies) 1986, respectively (Table 3). DIENER & al. (1976) isolated 5 *Aspergillus* species from soil in Alabama receiving sewage water and these were *A. brunneo-uniseriatus, A. flavus, A. fumigatus, A. parasiticus* and *A. versicolor*. MOUBASHER & ABDEL-HAFEZ (1978b) isolated 24 *Aspergillus* species in addition to 2 varieties from Egyptian soil receiving freshwater from River Nile during January-December 1972 and 1973, of which *A. niger, A. fumigatus, A. terreus, A. nidulans* and *A. sydowi* were isolated in high seasonal frequency of occurrence. *A. falvus* var. *columnaris* and *A. nidulans* were recovered from soil receiving sewage water in moderate seasonal frequency of occurrence. The remaining *Aspergillus* species (13 species + 2 varieties) were of low or rare seasonal frequency of occurrence.

Penicillium occupied the second place with regard to the number of cases of isolation. It recovered from 20 months (out of 24) contributing 29.2 % of total fungi. Its count did not displayed seasonal periodicities and the maxima were obtained in February (62.8 % of total fungi) and March (48.9 %) 1985. It was represented by 15 species of which *P. chrysogenum* was the most prevalent, and its count was parallel to those of the genus. *P. nigricans, P. funiculosum* and *P. brevicompactum* were isolated in moderate seasonal frequency of occurrence. DIENER & al. (1976) isolated 9 species of *Penicillium* from soil receiving sewage in Alabama, of which *P. brevicompactum, P. corylophilum* and *P. cyclopium* are the most common. The remaining *Penicillium* species (11 species) were isolated of low or rare seasonal frequency of occurrence (Table 1).

Mucor ranked third according to the number of cases of isolation. It recovered from 18 months contributing 8.8 % of total fungi. Its monthly counts did not show any regular trend and the maxima were recorded in May (51.6 colonies) and August (52.8 colonies) 1985 (Table 2 and Figure 2). Three species of *Mucor* were identified of which *M. hiemalis* was the most prevalent and its count was parallel to those of the genus; *M. circinelloides* and *M. racemosus* were less frequent. MOUBASHER & ABDEL-HAFEZ (1978 a, b) isolated the preceding three species, but with variable densities and frequencies, from Egyptian cultivated soil irrigated by water from River Nile.

Fusarium was also one of the basic components during the experimental period. It was recorded in 16 months donating 4.5 % of total fungi. Its total count was irregularly fluctuated and the maximum were obtained in March (36 colonies) 1985 (Table 2 and Figure 3). COOKE & PIPES (1970) found that *Fusarium* was one of the common fungi on soil receiving sewage. It was represented by 7 species and 1 variety of which *F. solani* and *F. oxysporum*

Table 3 – Monthly counts (per mg dry soil) of the most common fungal species recovered on glucose agar during January 1985 to December 1986.
Tableau 3 – Espèces de champignons les plus fréquemment isolées sur glucose entre Janvier 1985 et Décembre 1986.

Months / Species	1985												1986											
	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	[illegible]	D
Aspergillus fumigatus	2	9	4	0.6	1.8	1.6	[illegible]	1.2	4	93	42	50	5	12	30	16	78	19	7	23	25	5	9	6
A. niger	[illegible]	11	69	1.4	44.4	0.4	0.6	9.0	–	10	–	–	–	9	4	3	9	1	–	–	5	–	2	1
A. sydowi	–	–	13	2.2	–	0.2	3.0	8.4	4	4	15	25	–	–	–	2	–	6	–	2	–	4	5	5
A. terreus	–	7	1	1.6	–	0.4	40.8	–	–	–	–	4	–	–	2	–	16	43	–	–	4	9	15	5
A. flavus	–	4	14	0.4	9.6	–	–	13.8	–	5	–	5	4	–	–	–	–	2	–	15	17	–	5	5
Penicillium chrysogenum	–	138	140	12.0	6	0.8	5.4	27.6	–	7	15	61	–	–	5	–	7	–	7	6	19	70	30	4
Mucor hiemalis	11	18	14	2.6	–	–	–	15.6	–	19	–	40	2	–	–	–	8	–	5	2	10	–	4	–

were recovered in moderate seasonal frequency of occurrence. These 2 species were also prevalent in Egyptian cultivated soils receiving water from River Nile (MOUBASHER & ABDEL-HAFEZ, 1978 a, b). *F. moniliforme, F. poae, F. equiseti, F. moniliforme* var. *subglutinans, F. semitectum* and *F. tricinctum* were less frequent (Table 1).

Acremonium (represented by *A. rutilum, A. strictum* and *A. implecatum*), *Scopulariopsis (S. brevicaulis* and *S. brumptii*), *Botryotrichum (B. atrogriseum* and *B. piluliferum*) and *Trichoderma (T. viride* and *T. album*) were isolated in moderate seasonal frequency of occurrence. The remaining genera and species were isolated in low or rare frequency of occurrence and listed in Table 1.

Comparison between the present results and those obtained from clay soils irrigated by water from River Nile during January - December 1972 & 1973 (MOUBASHER & ABDEL-HAFEZ, 1978 b) the following observations were drawn : 1 - Sewage effluents increased the salinity and organic matter contents of soils. 2 - The total count of fungi in soils receiving sewage was very high and reached to 30234 colonies per mg dry soil in 24 samples (compared with 1317.4 colonies/mg dry soil in 24 samples irrigated by water from River Nile). 3 - There is basic similarities between the mycoflora of the soils irrigated with sewage with the others and the most prevalent genera are *Aspergillus, Penicillium, Mucor* and *Fusarium*. But *Rhizopus* and *Humicola* which are of high seasonal frequencies in soil receiving water from the River Nile, retreated to a backward situation (low or rare frequency) in soils irrigated by sewage. 4 - *Aspergillus* and *Penicillium* contributed the broadest spectrum of species in both soils. Also, a narrowest species was collected from sandy soils on glucose agar at 28°C (74 species + 4 varieties) receiving sewage water (compared with 112 species + 2 varieties in clay soils irrigated by water from River Nile).

II - Fungi recovered on cellulose agar :

The results in Table 1 show clearly that a narrower spectra of genera and species were collected on cellulose (23 genera and 48 species) than on glucose agar plates (26 genera and 74 species + 4 varieties) and this is due to glucose which is a more easily utilizable carbohydrate by fungi. Therefore, the monthly total counts of cellulose-decomposing fungi were lowest and fluctuated between 12.8 and 158 colonies per mg dry soil. This is in agreement with the results obtained by MOUBASHER & al. (1985). The total counts of cellulose-decomposing fungi irregularly fluctuated and the maxima were recorded in May (158 colonies) and October (158 colonies) 1986, and the minima in April (12.8 colonies) and June (31.8 colonies) 1985 as shown in Table 2 and Figure 1. On the other hand, the results obtained on cellulose agar were basically similar to those on glucose and the most frequent genera encountered were *Aspergillus* (10 species + 1 variety), *Penicillium* (7 species), *Mucor* (1 species), *Fusarium* (3 species), *Acremonium* (1 species) and *Stachybotrys* (2 species). Their counts were irregularly fluctuated and the peaks were recorded in May 1986, June 1986, October 1986 and February 1985. From the preceding genera *A. fumigatus, A. flavus, A. nidu-*

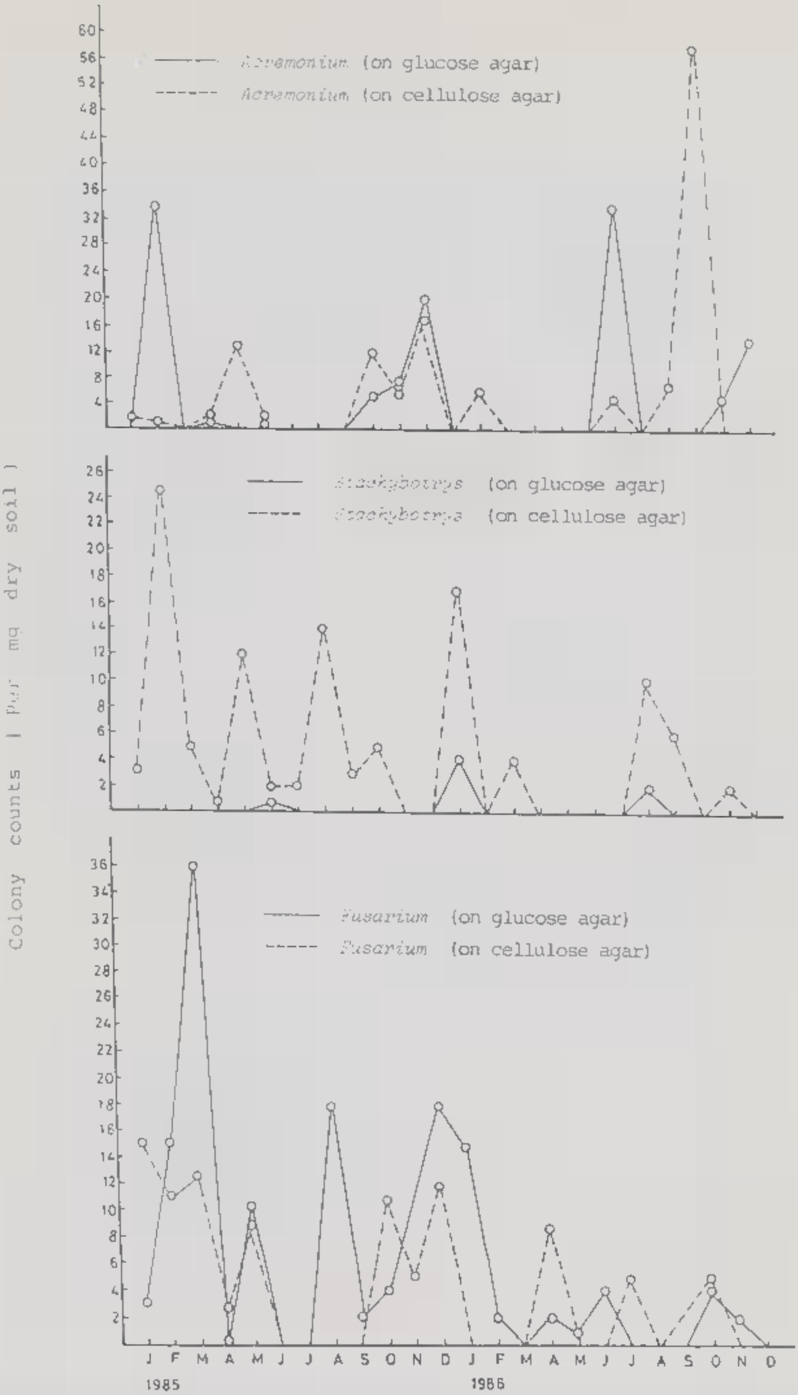


Figure 3 — Monthly counts (calculated per mg dry soil) of *Fusarium*, *Stachybotrys* and *Acremonium* recovered on glucose- and cellulose- Czapek's agar during January 1985 - December 1986.

Figure 3 — Dénombrements mensuels des *Fusarium*, *Stachybotrys* et *Acremonium* isolés sur milieux Czapek (glucose et cellulose) entre Janvier 1985 et Décembre 1986.

Table 4 — Monthly counts (per mg dry soil) of the most common fungal species recovered on cellulose agar during January 1985 to December 1986.

Tableau 4 — Espèces de champignons les plus fréquemment isolées sur cellulose entre Janvier 1985 et Décembre 1986.

Months / Species	1985												1986											
	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D
Aspergillus fumigatus	1.6	1	–	0.2	–	15.6	4.2	1.2	–	50	85	50	19	20	21	38	76	50	10	10	7	5	38	19
A. flavus	–	–	–	0.4	0.6	1.2	33.0	0.6	4	–	2	4	10	4	3	10	6	11	16	–	–	14	30	25
A. nidulans	2.4	1.8	0.4	0.2	3.0	0.6	3.6	4.8	–	–	2	–	2	–	–	–	34	26	–	–	–	–	–	–
Penicillium chrysogenum	–	0.8	0.4	1.6	1.2	1.8	3.6	–	–	–	–	–	–	4	5	5	–	8	9	–	5	13	13	5
Stachybotrys chartarum	3.2	21.4	3.0	–	–	1.8	1.8	13.8	3.0	5	–	–	19	–	4	–	–	–	–	10	6	–	2	–
Acremonium strictum	1.8	1.4	–	0.2	13.2	1.8	2.4	–	–	12	5	18	–	5	–	–	–	–	5	–	7	58	–	–
Mucor racemosus	3.2	6.2	0.2	0.6	8.4	–	–	–	8.0	9	–	9	5	10	–	5	12	4	20	–	12	14	–	–

lans, P. chrysogenum, M. racemosus, A. strictum and *S. chartarum* were isolated in high seasonal frequency of occurrence (Table 1). Their counts were irregularly fluctuated and almost parallel to those of the genera and the best counts were estimated in November (85 colonies) 1985, July (33 colonies) 1985, May 1986 (34 colonies), October and November 1986 (13 colonies), July (20 colonies) 1986, October (58 colonies) 1986 and February (21.4 colonies) 1985, respectively (Table 4). Most of the preceding species were previously isolated and common on cellulose agar plates from Wadi Bir-El-Ain and salts marshes soils in Egypt as recorded by ABDEL-HAFEZ & al. (1978) and MOUBASHER & al. (1985).

Four genera were isolated in moderate seasonal frequency of occurrence and these were *Scopulariopsis* (2 species), *Botryotrichum* (1 species), *Trichoderma* (2 species) and *Chaetomium* (2 species). From the preceding genera *S. brevicaulis, B. atrogriseum, T. viride* and *C. globosum* were the most prevalent. The remaining genera and species were of low or rare seasonal frequency of occurrence (Table 1). Most of the fungal species recovered on cellulose agar plates are well known as cellulose decomposer, but with variable degrees, as recorded by several researchers (FLANNIGAN, 1970; MALIK & EGGINS, 1970; ABDEL-HAFEZ & al., 1978; MOUBASHER & al., 1985; RAPER & FENNEL, 1965; STEWART & WALSH, 1972; TRIBE, 1961, 1966).

It is worthmentioning that eleven species have been recorded on cellulose which are not collected on glucose. Most are typical cellulolytic fungi. Also the seasonal frequency of occurrence of numerous fungi was however increased on cellulose than on glucose agar; example *A. nidulans* var. *latus* (from 2 to 7 samples), *M. racemosus* (5 to 16), *Acremonium strictum* (4 to 13), *Chaetomium* spp. (2 to 6) and *Stachybotrys chartarum* (3 to 13). On the contrary, the frequency of others was decreased; example *A. niger* (17 to 9), *A. terreus* (14 to 0), *A. sydowi* (15 to 4), *Penicillium nigricans* (8 to 4), *P. brevicompactum* (6 to 3), *P. oxalicum* (5 to 2), *M. hiemalis* (13 to 0), *M. circinelloides* (8 to 0) and *A. rutilum* (8 to 0) as shown in Table 1.

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